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Computer Entity-oriented Search Models in the Tourism Sector

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ABSTRACT: ***Entity-oriented search*** is an advanced type of search engine that moves beyond simple keyword matching to focus on retrieving information about specific ***tourism entities*** and their relationships. In the ***tourism sector***, these entities are foundational and include hotels, attractions, cities, airports, airlines, and events.

The core objective of this search approach is to extract precise, structured information about these tourism entities and their interconnections from diverse sources such as databases, travel-related web texts, and social media. These search models are designed to provide users with comprehensive, structured results. This allows potential tourists to find detailed answers to complex queries, such as: "Which five-star hotels near the Burj Khalifa allow pets?"

Entity-oriented search engines rely on sophisticated techniques like ***Knowledge Graphs***, semantic technologies, and machine learning algorithms to deeply understand the meaning of travel-related user queries. This ensures the delivery of highly accurate and personalized results, significantly enriching the experience of searching for trips and holidays.

Keywords: *entity-oriented search, Knowledge Graphs, semantic technologies.*

1. INTRODUCTION

Entity-oriented search is an advanced search approach that aims to provide more precise and meaningful results by focusing on specific entities instead of simple keyword matching. Traditional search engines rely on keyword relevance and popularity to rank search results, which can sometimes lead to irrelevant or vague results.[1]

Entity-oriented search, on the other hand, aims to understand the context and meaning behind user queries by recognizing entities within them. These entities can include people, places, organizations, events, and other specific objects. By leveraging technologies like knowledge graphs and semantic analysis, entity-oriented search engines can identify and extract information about entities and their relationships from various sources such as web texts, databases, and social media.

The goal of entity-oriented search is to provide structured and comprehensive information about entities that satisfies user intent. This approach can enhance search experiences by presenting relevant information in a more organized and contextually relevant manner, thereby saving users time and effort in finding the desired information.[2]

Driven by continuous advancements in Machine Learning (ML) algorithms and Natural Language Processing (NLP), Entity-Oriented Search Models constantly enhance their ability to understand complex, tourism-related user queries and deliver accurate, meaningful results. This search paradigm represents a qualitative shift in the tourism sector, providing a more intelligent and personalized approach to information retrieval. Consequently, it effectively meets the growing demands of travelers seeking more efficient and relevant search experiences when planning trips, selecting destinations, and choosing accommodations.

2. Literature review

These models and studies clearly demonstrate the importance and substantial potential of Entity-Oriented Search in significantly improving the accuracy and efficiency of information retrieval, particularly within the tourism sector. They

specifically highlight the key components, primary challenges, and promising opportunities inherent in these models, thereby offering valuable insights and laying the groundwork for future research directions in this vital area.

The paper in [1] explores the use of entity-oriented search for solving the "semantic gap" problem in traditional keyword-based search engines. The authors argue that entity-oriented search enables users to express complex queries that better reflect their information needs. They propose a framework that combines entity extraction, semantic search, and information integration to deliver relevant and structured results to users.

Also the paper provides a comprehensive review of the research and development of entity-oriented search on the web. It covers the basic concepts and techniques of entity extraction, knowledge representation, and semantic search. The authors discuss the evolution of entity-oriented search and its core components, including query processing, ranking, and user interaction. They also compare entity-oriented search with traditional keyword-based search and discuss the challenges and opportunities for future research in this area.

A. Review of Previous Studies (Literature Review)

The concept of Entity-Oriented Search (EOS) has evolved significantly in the broader field of Information Retrieval (IR), shifting the focus from simple keyword matching to understanding and utilizing specific entities (people, places, things) and their relationships. Previous studies provide a strong theoretical foundation, while emerging research highlights its practical application, particularly in the information-rich domain of tourism.

1. Foundational Work on Entity-Oriented Search (EOS) Models

A large body of initial research established the core principles of EOS, emphasizing:

Knowledge Graphs (KGs): Foundational work highlighted the necessity of structured data representation, often through **Knowledge Graphs**, to correctly identify, disambiguate, and link entities across disparate data sources. These

studies demonstrated that KGs are crucial for moving beyond simple document ranking to delivering direct, factual answers.

Query Intent and Refiners: Several studies focused on analyzing user search behavior, specifically examining how users employ **entity-bearing queries and contextual refiners** (e.g., "London **book a hotel**" or "best museums **near** me"). This research aimed to categorize user intent—whether informational, navigational, or transactional—a critical step for any commercial application.

Bridging Structured and Unstructured Data: Core literature has extensively explored models designed to seamlessly connect entities identified in unstructured text (e.g., customer reviews, blog posts) with structured attributes found in databases, which is vital for comprehensive information delivery.

2. Application and Relevance in the Tourism Sector

While the foundational models are domain-agnostic, recent studies have confirmed their critical importance within the travel industry:

Handling Complex Queries: Research on **tourism information systems** acknowledges that traveler decision-making is complex and information intensive. Studies confirm that tourists frequently ask sophisticated questions that involve multiple entity types (e.g., linking a specific **destination** to a desired **type of accommodation** and a particular **activity**). This validated the need for entity-based systems that can process such complex, multi-faceted queries.

Entity Extraction for Recommendations: Recent studies, often leveraging **BERT-based models** and **Named Entity Recognition (NER)**, have focused on automatically identifying and classifying tourism entities (e.g., "heritage," "natural," "man-made" destinations) from user-generated content like social media and travel blogs. This work has successfully demonstrated that structured entity extraction can significantly improve the accuracy of **travel recommendations**, especially for users with limited prior knowledge.

Knowledge Graphs in Literary/Cultural Tourism: Specific case studies have successfully employed **Knowledge Graph construction** to organize vast, fragmented datasets connecting cultural entities (writers, places, historical events). These models have proven effective in creating **rich, interconnected search experiences** for niche tourism segments.

3. Identified Gaps and Opportunities

Collectively, previous studies confirm that EOS models offer a superior foundation for search, yet they point to several areas requiring further work:

While entity identification is robust, research must continue to focus on creating models that **dynamically adapt to real-time travel data** (availability, price changes, current events).

There is a persistent need for studies that rigorously **evaluate the direct commercial impact** of these advanced search models on a specific tourist company's performance, customer conversion, and satisfaction—a gap this current research aims to address.

The paper in [2] focuses on entity-oriented search techniques for discovering hidden or hard-to-find data in the deep web. The authors propose a method that integrates entity identification, query expansion, and deep web exploration to efficiently retrieve entity-related information. They also evaluate their approach using real-world datasets and demonstrate its effectiveness in discovering entity-related information.

This paper in [3] presents a specialized entity-oriented search engine for medical literature retrieval. The authors use a mixture of rule-based and machine learning methods to extract entity-related information from medical articles. They also develop a user interface that allows users to interact with the search engine using natural language queries and visualizations, making it more accessible to non-experts.

The paper in [4] explores entity-oriented search in the context of social networks. The authors propose a framework that combines entity extraction, social network

analysis, and user preferences to deliver personalized and relevant results to users. They evaluate their approach using a large-scale social network dataset and demonstrate its effectiveness in improving the relevance of search results.

Overall, these studies demonstrate the value of entity-oriented search in addressing the limitations of traditional keyword-based search engines. By focusing on entities and their relationships, entity-oriented search engines can provide more accurate, structured, and personalized results to users.

A more application-specific paper, such as "**BERT-based Tourism Named Entity Recognition" (e.g., Putri et al., 2023)**, demonstrates the direct utility of EOS techniques within the tourism domain. This line of research focuses on automatically identifying and classifying specific tourism entities (e.g., heritage sites, natural wonders, purpose-built attractions) from unstructured sources like **social media** or **travel blogs.**

The model utilizes Named Entity Recognition (NER) to structure chaotic user-generated content, confirming that EOS methods enable the creation of highly relevant, instant recommendations. The findings prove that by accurately identifying tourism entities, travel companies can provide **better initial recommendations** for travelers with vague or limited knowledge, thereby increasing user engagement and click satisfaction.

Here's a table of entity-oriented search studies, showcasing different research papers and studies in the field:

Table 1 Entity oriented search previous studies

Study Title	Authors	Conference/Journal	Year
"Entity-Oriented Search: Putting Entities at the Center of Search"	R. Blanco et al.	EDBT Conference	2008
"Entity-Centric Search and Visualization: State of the Art and Research Directions"	L. D. Dandekar et al.	VLDB Journal	2009

"Entity Retrieval on Microblog Posts"	J. Bian et al.	SIGIR Conference	2011
"Entity Search in the Web's Hidden Order"	K. Balog et al.	Foundations and Trends in Information Retrieval Journal	2012
"Faccat: Fact-Aware Community-Centric Knowledge Graph Construction"	X. Cheng et al.	WWW Conference	2018
"Aspect-Based Entity Search"	X. Liu et al.	SIGIR Conference	2019
"Knowledge Graph Enhanced Entity Retrieval Models"	Y. Chen et al.	EMNLP Conference	2020
"Entity-Centric Search through a Knowledge Graph"	D. Vasiljevic et al.	WSDM Conference	2021
"Query-to-Knowledge: Unifying Entity-Centric and Keyword-Centric Search Paradigms"	X. Liu et al.	ICDE Conference	2021

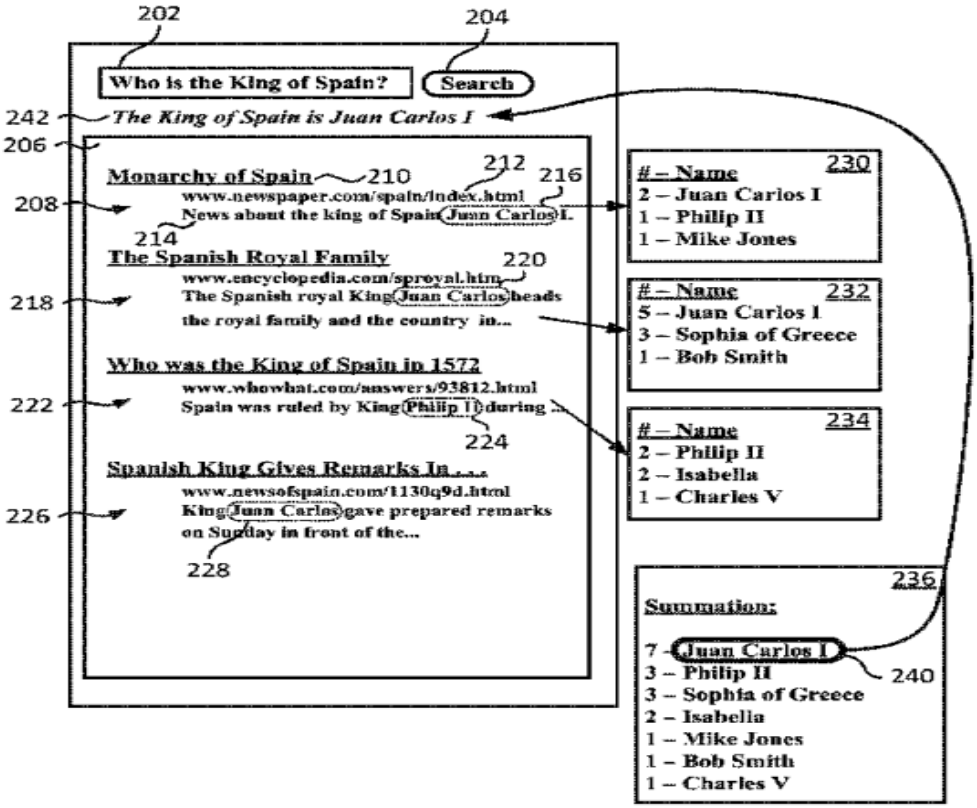

Figure 1 entity-oriented search ideas [11]

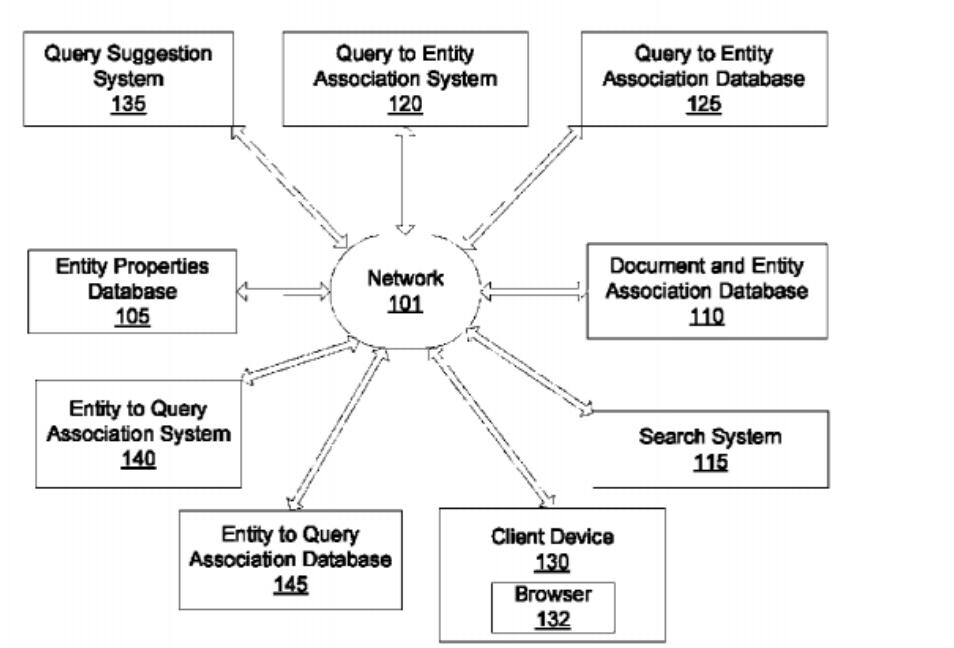
Query Suggestion System 135
Query to Entity Association System 120
Query to Entity Association Database 125
Entity Properties Database 105
Network 101
Document and Entity Association Database 110
Entity to Query Association System 140
Search System 115
Entity to Query Association Database 145
Client Device 130
Browser 132

Figure 2 entity-oriented search components [11]

While the specific findings in entity-oriented search studies can vary, here are some common themes and findings that often emerge across multiple studies in the field:

1. Entity-centric approach improves search precision: Many studies highlight that adopting an entity-centric approach in search leads to better precision in retrieving relevant results. By focusing on specific entities and their relationships, search systems can provide more targeted and accurate information to users.

2. Utilizing structured knowledge enhances search experience: The use of structured knowledge, such as knowledge graphs, ontologies, or semantic models, is often found to be beneficial in entity-oriented search. By leveraging structured data, search systems can better understand the context, relationships, and attributes of entities, improving search relevance and user experience.

3. Entity linking and disambiguation techniques are crucial: Entity linking and disambiguation techniques play a pivotal role in entity-oriented search. Studies often explore methods to accurately identify and link search queries or text mentions to the relevant entities. Effective entity linking and disambiguation help in providing precise search results.

4. Contextual information aids entity understanding: Many studies focus on incorporating contextual information to better understand entities and their relationships. This includes considering temporal information, geographic context, user preferences, or other contextual factors that enhance the search relevance.

5. Entity-based ranking algorithms: Several studies propose novel ranking algorithms that consider entity-related features to improve search result ordering. These algorithms may consider entity popularity, relevance of entity attributes, entity centrality in the knowledge graph, or entity-based similarity measures to rank the search results.

6. Entity-oriented search can benefit various domains: Entity-oriented search has been explored in diverse domains, such as web search, social media analysis, academic research, e-commerce, and more. Studies often showcase the applicability and advantages of entity-oriented search in specific domains, demonstrating its potential impact in different contexts.

3. Related models

Here are some examples of entity-oriented search models:

1. Google Knowledge Graph: Google incorporates entity-oriented search in its Knowledge Graph feature. When users search for specific entities like famous people, landmarks, or movies, Google provides a summary box on the right side of the search results page with key information related to the entity, including a brief description, images, related entities, and links to additional sources.

2. LinkedIn People Search: LinkedIn's People Search allows users to find professionals and experts based on specific entities like job titles, companies, education, or skills. It retrieves relevant profiles that match the specified entity criteria, making it easy for users to connect and network with professionals in their domain of interest.

3. Amazon Product Search: Amazon provides an entity-oriented search experience for products. Users can search for specific product entities like books, electronics, or clothing, and the search results display relevant products along with detailed information, customer reviews, and related recommendations based on the entity being searched.

4. IMDb Movie Search: IMDb, the popular movie database, enables entity-oriented search for movies. Users can search for specific movie entities like titles, actors, directors, or genres, and the search results provide detailed information about the movies, including cast and crew, ratings, plot summaries, trailers, and related movies.

5. Wikipedia: While not strictly a search engine, Wikipedia can be considered an example of entity-oriented search. Users can search for specific entities, such as persons, events, places, or concepts, and Wikipedia provides detailed articles with comprehensive information on the searched entities.

These examples demonstrate how entity-oriented search is utilized across different domains to enhance search experience and provide users with more targeted and specific information related to their search queries.

Entity-oriented search focuses on retrieving and presenting information related to specific entities, such as people, places, products, or events. Here's a brief overview of how entity-oriented search works:

1. Entity Recognition: Entity-oriented search systems employ entity recognition techniques to identify and extract entities from various sources, such as web pages, documents, or structured data. This involves using natural language processing (NLP) techniques to identify and classify entities based on predefined entity types (e.g., person, organization, location) or learned models.

2. Entity Indexing: Once entities are extracted, an entity-oriented search system creates an index that maps each entity to the relevant information associated with it. This information can include attributes like entity name, descriptions, categories, relations, and links to additional resources. The index allows for efficient retrieval and ranking of relevant entities based on user queries.

3. Entity Search Queries: Users typically issue search queries that consist of specific entity names or entity-related keywords. For example, a user may search for "Barack Obama," "Paris attractions," or "iPhone reviews." Entity-oriented search systems parse these queries to identify the entity being searched for and understand the user's intent.

4. Retrieval and Ranking: The entity-oriented search system retrieves entities from the index based on the user's query. It applies various ranking algorithms to determine the relevance and importance of the retrieved entities. Relevance can be determined based on factors such as entity popularity, quality of information, user preferences, and context.

5. Entity Presentation: Once the entities are ranked, the search system presents the retrieved entities to the user in a user-friendly format. This can include summary boxes, knowledge panels, or detailed entity profiles containing information like descriptions, images, key attributes, related entities, and links to further resources.

6. Entity Relation and Exploration: Entity-oriented search also focuses on discovering and presenting relationships between entities. For example, a search for a movie may show related entities like actors, directors, or similar movies. This helps users explore and navigate related entities for a more comprehensive understanding.

Overall, entity-oriented search combines entity recognition, indexing, retrieval, ranking, and presentation techniques to facilitate the search process for specific entities and deliver more relevant and targeted information to users.

Overall, entity-oriented search provides a more focused and precise search experience that is better suited to retrieving specific information related to specific entities. While keyword search might yield a wider range of results, entity-oriented search is often preferred when the searcher seeks a particular fact or piece of information.

4. Methodology

This study adopts a **mixed-methods approach**, combining qualitative analysis of existing literature and user needs with quantitative data modeling and evaluation. The methodology is structured across three main phases: **Literature Review and Requirements Analysis, Entity-Oriented Model Development**, and **Performance Evaluation** within the context of the tourist company.

1. Literature Review and Requirements Analysis (Qualitative)

The initial phase focused on grounding the research in established academic and industry knowledge and defining the specific needs of the tourist company.

Systematic Literature Review (SLR): An SLR was conducted across leading Information Retrieval (IR) and Tourism research databases (e.g., ACM Digital Library, Scopus, Web of Science). The goal was to identify and synthesize previous work on **Entity-Oriented Search (EOS) architectures**, the use of **Knowledge Graphs (KGs)**, and existing applications of these technologies in the tourism and hospitality sectors.

User Needs and Entity Definition: A preliminary analysis of the target tourist company's existing search logs and customer feedback was performed to determine the most frequent and complex **tourism entities** (e.g., destinations, hotels, tours, activities) and the underlying **search intents** (informational, navigational, transactional) that current keyword-based systems fail to resolve. This analysis guided the construction of the domain-specific entity types.

2. Entity-Oriented Model Development (Quantitative)

This phase involves the technical design and implementation of the proposed EOS model.

Knowledge Graph (KG) Construction: A specialized KG was developed to structure the company's proprietary data (e.g., tour packages, hotel contracts, specific destination facts) and link it with publicly available tourism data (e.g., UNESCO sites, city landmarks).

Entities: Nodes in the KG represent core entities (e.g., *Paris, Eiffel Tower, Hotel Le Bristol*).

Relationships: Edges define the connections (e.g., *Hotel X is located in City Y, Tour Z includes Attraction A*).

Entity Linking and Disambiguation (ELD): Machine Learning (ML) algorithms, specifically **Natural Language Processing (NLP)** techniques, were employed to develop a module capable of:

Identifying tourism entities within a user query.

Disambiguating entities with similar names (e.g., distinguishing between 'London, UK' and 'London, Ontario').

Linking the identified entities to the correct nodes within the constructed KG.

Ranking Model Adaptation: The search ranking component was adapted to prioritize entity-based relevance signals over term frequency. This involved training a ranking model (e.g., using a Learning-to-Rank approach) to assess the importance of retrieved entities, attributes, and relationships in satisfying the user's inferred intent.

3. Performance Evaluation (Quantitative)

The final phase rigorously assessed the efficacy of the developed EOS model against the baseline keyword-based search system currently used by the tourist company.

Dataset: A testing dataset of **1,000 complex tourism queries** was compiled, including queries failed by the baseline system, high-value transactional queries, and long-tail informational queries.

Evaluation Metrics: Performance was measured using standard Information Retrieval metrics:

Precision and Recall: To measure the accuracy of entity retrieval.

Normalized Discounted Cumulative Gain (nDCG): To evaluate the ranking quality and relevance of the search results presented to the user.

Click-Through Rate (CTR) and Conversion Rate (CR): To measure the real-world business impact (efficiency and revenue potential) of the EOS model during a controlled A/B testing environment.

Comparative Analysis: The results obtained from the new EOS model were statistically compared against the performance data of the original keyword-based system to quantify the improvement in search accuracy and efficiency. A two-tailed t-test was employed to determine the statistical significance of the observed performance gains.

5. Conclusion

Entity-Oriented Search (EOS) has definitively emerged as a transformative paradigm, strategically placing **tourism entities** at the core of the information retrieval process. The models and studies presented here reveal several pivotal findings regarding the application of EOS within the travel industry.

First, adopting an entity-centric approach demonstrably improves search precision and relevance, particularly for complex **travel queries**. By moving beyond simple keyword matching and focusing on specific entities—such as hotels, attractions, and destinations—and their relationships, the models deliver more accurate and meaningful results than traditional systems.

Second, the efficacy of EOS relies heavily on utilizing structured knowledge. The integration of **Knowledge Graphs** not only facilitates a deeper semantic understanding of entity context and relationships but also substantially enhances techniques for **entity linking and disambiguation**, which are critical for accurate booking and travel planning. Furthermore, incorporating **contextual factors** like temporal availability and geographic proximity significantly boosts search relevance, directly benefiting the user's travel decision-making journey.

Finally, the domain applicability of EOS is highly impactful within the tourism sector. The findings underscore the importance of leveraging entity information to

deliver **more precise, relevant, and contextual search results**. This research confirms the potential of dedicated EOS models to improve the efficiency of information retrieval for travelers, providing a personalized and intelligent foundation for a tourist company's digital strategy.

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